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ORIGINAL RESEARCH

DIAGNOSTIC IMAGING IN A DIRECT-ACCESS SPORTS PHYSICAL THERAPY CLINIC: A 2-YEAR RETROSPECTIVE PRACTICE ANALYSIS

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ABSTRACT

Background: While advanced diagnostic imaging is a large contributor to the growth in health care costs, direct-access to physical therapy is associated with decreased rates of diagnostic imaging. No study has systematically evaluated with evidence-based criteria the appropriateness of advanced diagnostic imaging, including magnetic resonance imaging (MRI), when ordered by physical therapists. The primary purpose of this study was to describe the appropriateness of magnetic resonance imaging (MRI) or magnetic resonance arthrogram (MRA) exams ordered by physical therapists in a direct-access sports physical therapy clinic.

Study Design: Retrospective observational study of practice.

Hypothesis: Greater than 80% of advanced diagnostic imaging orders would have an American College of Radiology (ACR) Appropriateness Criteria rating of greater than 6, indicating an imaging order that is usually appropriate.

Methods: A 2-year retrospective analysis identified 108 MRI/MRA examination orders from four physical therapists. A board-certified radiologist determined the appropriateness of each order based on ACR appropriateness criteria. The principal investigator and co-investigator radiologist assessed agreement between the clinical diagnosis and MRI/surgical findings.

Results: Knee (31%) and shoulder (25%) injuries were the most common. Overall, 55% of injuries were acute. The mean ACR rating was 7.7; scores from six to nine have been considered appropriate orders and higher ratings are better. The percentage of orders complying with ACR appropriateness criteria was 83.2%. Physical therapist's clinical diagnosis was confirmed by MRI/MRA findings in 64.8% of cases and was confirmed by surgical findings in 90% of cases.

Conclusions: Physical therapists providing musculoskeletal primary care in a direct-access sports physical therapy clinic appropriately ordered advanced diagnostic imaging in over 80% of cases. Future research should prospectively compare physical therapist appropriateness and utilization to other groups of providers and explore the effects of physical therapist imaging privileging on outcomes.

Level of Evidence: Diagnosis, Level 3

Keywords: Diagnostic imaging, direct access, sports physical therapy

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The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the United States Army or Department of Defense.

The study protocol was approved by the Institutional Review Board at Keller Army Community Hospital, West Point, NY (Protocol #15-024).

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INTRODUCTION

Direct access to physical therapy evaluation and intervention has the potential to reduce costs and improve outcomes in musculoskeletal medicine. The results of multiple studies show that direct access to physical therapy is associated with improved patient outcomes and decreased costs, with minimal risk of harm to the patient.[1–6] The diagnostic accuracy of a physical therapists clinical examination has been shown to be the equivalent of orthopedic surgeons and well above non-orthopedic providers when compared to an MRI diagnosis.[3] Although more research on harm is needed, in a large cohort of over 50,000 patients in the U.S. military, no adverse events related to inappropriate patient management were reported by those who sought physical therapy services without a physician referral.[4] Additionally, numerous case reports describe the appropriate identification of patients whose pathology lies outside the scope of physical therapy by physical therapists operating in a direct-access setting.[1,6]

Advanced diagnostic imaging, which includes magnetic resonance imaging (MRI), computed tomography, and nuclear medicine imaging, is a large contributor to growth in health care spending in the United States. National expenditures on all medical imaging were approaching $100 billion in 2006, although the rate of growth is beginning to slow.[7,8] A high percentage of advanced imaging ordered by physicians in primary care clinics does not meet evidence-based appropriateness criteria.[7,9,10] In a review of over 500 advanced imaging orders by primary care physicians, 26% were considered inappropriate by physician reviewers using a computerized commercial evidence-based appropriateness system.[7] In a pre-authorization center using the American College of Radiology (ACR) Appropriateness Criteria, 15% of magnetic resonance imaging (MRI) examinations requests were considered inappropriate.[9] Overutilization of diagnostic imaging is, at best, associated with no effect on outcomes;[11–13] and in conditions of the spine, there is evidence to suggest that early utilization of diagnostic imaging may produce poorer outcomes with increased cost.[12–15]

Direct-access to physical therapy is associated with decreased rates of diagnostic imaging.[5] However, only four studies (only one of which was conducted in the U.S.) reported on the rate of diagnostic imaging.[16–19] It is unclear from the results of three of those studies whether the ordering provider was a physical therapist or physician.[17–19] A large portion of the research on cost effectiveness, efficiency, and clinical outcomes related to imaging utilization has examined advanced practice physical therapists (outside the U.S.) in an orthopedic screening role. Advanced practice physical therapists who screen patients referred to an outpatient orthopaedic surgery practice, are less likely to order radiographs and have lower costs associated with the care of non-surgical conditions when compared with orthopedic surgeons.[20–22]

The majority of physical therapists in the U.S. military provide some degree of direct-access musculoskeletal care and possess privileges to order both radiographs and advanced diagnostic imaging. All of the military services have physical therapists working in capacities that could be described as "primary care providers" for musculoskeletal care. These include providers in small outpatient medical clinics, within special operations communities, and during deployment to theaters of war. The United States Military Academy at West Point provides a setting to study this unique combination of clinical privileges. The patient population is relatively homogenous; the majority of patients are cadets between the ages of 18-24. In 2013-2014, 1,303 patients were evaluated at the Cadet Sports Physical Therapy Clinic. Many musculoskeletal injuries incurred by cadets are initially evaluated by physical therapists, either on the field during sports coverage or during walk-in musculoskeletal clinic hours. Rarely are cadets evaluated by primary care providers for musculoskeletal injuries.

No study has systematically evaluated with evidence-based criteria the appropriateness of advanced diagnostic imaging ordered by physical therapists in a direct-access clinic. The primary purpose of this study was to describe the appropriateness of magnetic resonance imaging (MRI) or magnetic resonance arthrogram (MRA) exams ordered by physical therapists in a direct-access sports physical therapy clinic. Secondary purposes were to describe the utilization rates of diagnostic imaging, describe the diagnostic accuracy of the physical therapist's clinical

Table 1. *Characteristics of the providers participating in the study*

	PT #1	PT #2	PT #3	PT #4
Years of experience	7	1	20	7
Board certification	OCS/SCS	NONE	OCS/SCS	OCS/SCS
Residency/Fellowship	YES	NO	YES	YES
Formal imaging training (instruction hours)	42	22	20	42

PT= physical therapist; OCS= orthopedic certified specialist; SCS= sports certified specialist.

examination compared to MRI findings and, if applicable, surgical findings, and to compare utilization, appropriateness, and diagnostic accuracy between board certified physical therapists and non-board certified physical therapists. It was hypothesized that:

1. Greater than 80% of advanced diagnostic imaging orders will comply with American College of Radiology (ACR) Appropriateness Criteria (ACR rating > 6).
2. All physical therapists will utilize radiographs and advanced diagnostic imaging at rates equal to or lower than those previously reported for primary care physicians.
3. Agreement between the clinical examination diagnosis and the MRI/surgical diagnosis will be greater than 75%.
4. Board certified physical therapists will utilize diagnostic imaging at lower rates and with increased appropriateness based on ACR criteria.

METHODS

This was a single-center retrospective cohort study that took place at United States Military Academy at West Point. The patient population consisted of over 4,500 Cadets, faculty, staff, and family members who live and work at West Point. Four physical therapists were included in this study; three were board certified and were post-professional residency/fellowship graduates. Clinical practice experience ranged from 1 to 20 years. All physical therapists possessed the same clinical privileges, no constraints had been placed on their ability to order any imaging modality, and they were unaware that their practice patterns were being evaluated. The majority of patients were young males (77%) and the majority of injuries were acute (55%). The demographics of the providers and patients in the study are presented in Tables 1 and 2. The study protocol was approved by the Institutional Review Board at Keller Army Community Hospital, West Point, New York (Protocol #15-024).

Table 2. *Patient demographics*

Patient Characteristics	Mean (SD) Ratio (%)
Age	24.8 (10.6)
Sex	
Male	77/108 (71.3%)
Female	31/108 (28.7%)
Acuity	
Acute	59/108 (55%)
Chronic	49/108 (45%)

SD= standard deviation.

The radiology picture archive and communication system (PACS) was searched for the two-year period between January 2013 to December 2014. One-hundred eight MRI or MRA examinations ordered by physical therapists practicing in a direct-access sports physical therapy clinic were identified. The total number of conventional radiograph orders and MRI/MRA orders were counted for each provider. For each patient with an MRI/MRA ordered by a physical therapist during that period, the electronic medical record (EMR) was reviewed and documentation from physical therapy encounters and radiology exams were extracted and de-identified.

Each de-identified case file was provided to a board-certified radiologist who determined the appropriateness of each MRI/MRA examination order based on ACR Appropriateness Criteria. The ACR Appropriateness Criteria are evidence-based guidelines developed to assist referring physicians and other providers with making the most appropriate imaging decision for a specific clinical condition.[23] Utilizing these guidelines may enhance quality of care and contribute to more efficient use of diagnostic imaging.[23] For each clinical condition, an ACR rating describes the level of appropriateness for each imaging study. The ACR rating scale ranges from 1-9. Scores of 7 and above indicate usually appropriate, scores of 4-6 indicate that the test may be appropriate, and scores of 3 or less indicate that the tests are usually not appropriate.[23] For the purposes of this study, scores of 7 or greater operationally defined as "appropriate" and scores of 6 or less were operationally defined as "inappropriate."[9] A modified example of the ACR appropriateness criteria for the evaluation of acute knee injuries is shown in Appendix 1.

The principal investigator physical therapist and co-investigator radiologist assessed agreement between the referring provider's clinical examination diagnosis and the MRI. The principal investigator thoroughly reviewed the patient's operative report to assess agreement between the clinical diagnosis and surgical findings. The provider's imaging order and clinical documentation were used to establish the clinical diagnosis. If the provider's clinical diagnosis did not match anything within the radiologist's report, or if the report was determined to be normal, the provider was not given credit for clinical diagnostic accuracy. When assessing agreement with MRI, a provider was given a great deal of latitude within their clinical diagnosis. For example, if the provider's clinical diagnosis was anterior shoulder instability and the MRI report noted an anterior-inferior glenoid labrum tear, then the provider was given credit for agreement. Additionally, in cases of multiple pathological findings on the MRI, a clinical diagnosis was considered accurate if any diagnosis within the assessment or radiology report matched. For example, if the MRI report described an ACL tear with a lateral meniscus tear, a provider was given credit for agreement if a diagnosis of an ACL tear or lateral meniscus tear was present.

Data analysis was performed using R version 3.1.3 and R Commander version 2.1-7. Chi-square tests were used to compare ACR compliance and clinical diagnostic accuracy between the three board certified and one non-board certified physical therapists. Odds ratios were calculated when chi-squared analyses were significant at the alpha = 0.05 level.

RESULTS

For the two-year study period, 1303 new patients were evaluated with 3562 total patient visits, resulting in orders for 521 radiographs and 108 MRI/MRA examinations. The overall utilization of diagnostic imaging is presented in Table 3.

The majority of the 108 MRI/MRA examination orders were for knee (31%) or shoulder (25%) injuries. The breakdown of the MRI/MRA examination orders by body region is shown in Figure 1. Physical therapists evaluated/re-evaluated patients for a mean of three visits prior to ordering MRI examinations. Radiographs were frequently ordered for injuries to the foot/ankle (21.1%), wrist/hand (18.8%), shoulder (16.9%), and knee (13.8%). The breakdown of the radiograph orders by body region is shown in Figure 2.

The mean ACR rating for advanced diagnostic imaging orders was 7.7 and the percentage of orders complying with the ACR criteria (rating ≥ 7) was 83.2%. Seven MRI/MRA orders could not be categorized within the ACR criteria because no criteria existed for their condition. Table 4 shows the ACR compliance across all physical therapists. There was not a

Table 3. *Overall utilization of diagnostic imaging*

	OVERALL	PT #1	PT #2	PT #3	PT #4
RADIOGRAPHS 2-year overall utilization [per new patient evaluation]	40.0% (521/1303)	33.6% (94/280)	40.1% (184/459)	37.8% (137/362)	52.5% (106/202)
MRI/MRA 2-year overall utilization [per new patient evaluation]	8.3% (108/1303)	7.5% (21/280)	7.4% (34/459)	11.9% (43/362)	5.0% (10/202)
RADIOGRAPHS 2-year overall utilization [per total # patient visits]	14.6% (521/3562)	12.7% (94/739)	13.6% (184/1353)	13.3% (137/1029)	24.0% (106/441)
MRI/MRA 2-year overall utilization [per total # patient visits]	3.0% (108/3562)	2.8% (21/739)	2.5% (34/1353)	4.2% (43/1029)	2.3% (10/441)

A "new patient evaluation" refers to the only the initial evaluation of the patient for the condition.
PT= physical therapist; MRI= magnetic resonance imaging; MRA= magnetic resonance arthrogram; #= number

significant association between ACR compliance and board certification (X^2 = 0.43, p = 0.51) (Figure 3).

Physical therapist's clinical diagnosis agreed with the MRI/MRA findings in 64.8% of cases and agreed with surgical findings in 90% of cases (Table 5). There was a significant association between board certification and clinical diagnostic accuracy (X^2 = 6.86, p = 0.008). Board certified physical therapists were 3.03 (95% CI 1.3, 7.08) times more likely to have documented the correct clinical diagnosis (based on MRI/MRA examination findings) than the non-board certified physical therapist (Table 6, Figure 3).

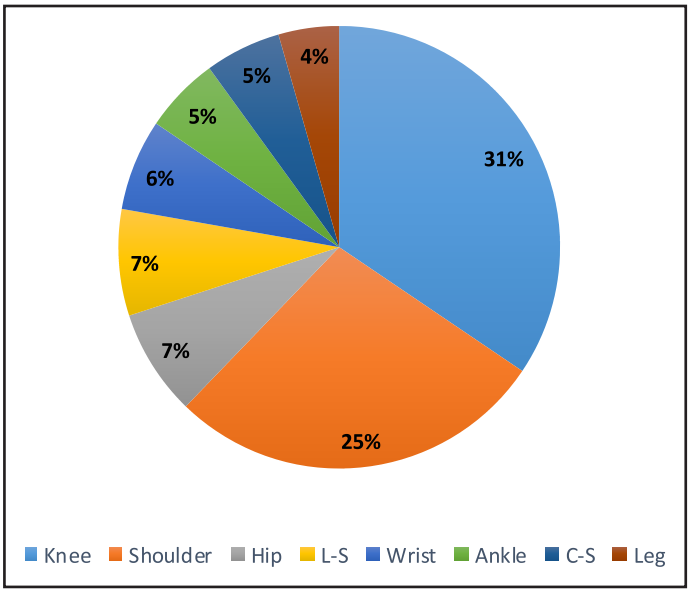

Figure 1. *Advanced imaging (MRI/MRA) by body region. L-S= lumbar spine; C-S= cervical spine.*

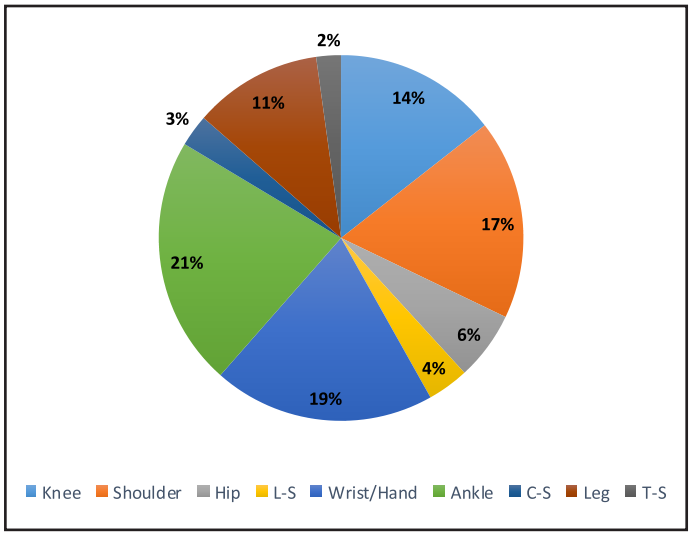

Figure 2. *Radiographs by body region. L-S- lumbar spine; C-S- cervical spine; T-S- thoracic spine.*

DISCUSSION

The primary purpose of this study was to describe the appropriateness and utilization of advanced diagnostic imaging by physical therapists in a direct-access sports physical therapy clinic. This is the first study to describe the appropriateness, systematically

Table 4. *Appropriateness of advanced diagnostic imaging [MRI/MRA]*					
	OVERALL	**PT #1**	**PT #2**	**PT #3**	**PT #4**
Mean (SD) ACR rating	7.7 (2.5)	8.3 (1.1)	7.6 (2.7)	7.7 (2.7)	7.0 (1.8)
ACR compliance (rating ≥ 7)	83.2% (84/101)	90.0% (18/20)	79.3% (23/29)	83.7% (36/43)	77.8% (7/9)
Mean (SD) visits prior to MRI/MRA	3.0 (2.2)	3.1 (2.7)	2.8 (2.6)	3.1 (1.8)	2.6 (3.2)

PT= physical therapist; ACR= American College of Radiology; MRI= magnetic resonance imaging; MRA= magnetic resonance arthrogram.

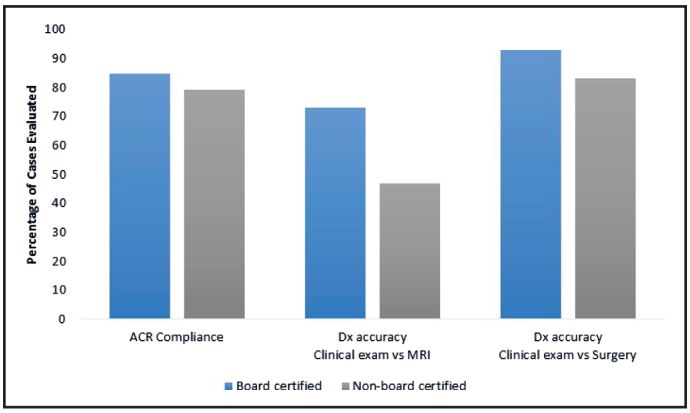

Figure 3. *Appropriateness of advanced diagnostic imaging and accuracy of the clinical exam in three board certified PTs versus a single non-board certified PT, expressed as a percentage of cases evaluated. ACR- American College of Radiology; Dx-diagnostic; MR-, magnetic resonance imaging.*

evaluated with evidence-based criteria, and the utilization of advanced diagnostic imaging ordered by physical therapists in a direct-access setting. In over 80% of cases, a board-certified radiologist considered physical therapist MRI/MRA orders appropriate by ACR criteria. Based on imaging rates published in other studies, physical therapists did not appear to over-utilize advanced diagnostic imaging, ordering MRI/MRA in only 8% of all patient evaluated.

While no prior studies have examined the appropriateness of advanced diagnostic imaging orders by physical therapists, a few studies have examined physicians. Lehnert et al reported that 74% of MRI and computed tomography (CT) orders by primary care physicians were appropriate when evaluated with a proprietary software program.[7] Using the ACR criteria, Levy et al reported that 50-60% of MRI requests received at a pre-authorization center were appropriate (rating > 7).[9] Petron et al reported that only 12% of MRI orders for chronic knee pain would have been ordered by orthopedic surgeons who retrospectively reviewed the case files.[10] In this study of physical therapists evaluating musculoskeletal injuries in a direct-access setting, 83% of all MRI/MRA orders were considered appropriate, exceeding the highest previously reported level of 74% by Lehnert et al.

Table 5. *Diagnostic accuracy of the clinical exam*					
	OVERALL	**PT #1**	**PT #2**	**PT #3**	**PT #4**
Diagnostic accuracy Clinical exam vs MRI	64.8% (70/108)	85.7% (18/21)	47.1% (16/34)	72.1% (31/43)	50% (5/10)
Diagnostic accuracy Clinical exam vs Surgery	90.0% (18/20)	80% (4/5)	83.3% (5/6)	100% (8/8)	100% (1/1)

While every patient had an MRI prior to surgery; only 20% of patients with an MRI eventually had surgery.
PT= physical therapist; MRI= magnetic resonance imaging

Table 6. *Association of board certification with accurate clinical diagnosis*

	Accurate Diagnosis *(MRI reference standard)*	Inaccurate Diagnosis *(MRI reference standard)*
Board certified PT	54	20
Non-board certified PT	16	18

Board certified physical therapists were 3.03 times more likely to arrive at a diagnosis that matched the MRI diagnosis than the non-board certified physical therapist. $X^2 = 5.77$, $p = 0.008$ PT= physical therapist; MRI= magnetic resonance imaging

This study did not examine the appropriateness of the radiographs ordered by this sample of physical therapists. When examining the ACR criteria, the only body region where radiographs ordered during the initial evaluation do not have a rating of 9 is the lumbar spine. In this study, only 18 of the 521 (3.5%) radiograph orders were for the lumbar spine. Additionally, it would not be feasible for an independent radiologist to determine appropriateness for over 500 orders. In the future, electronic health care databases may be able to provide information regarding the appropriateness of radiographs ordered by physical therapists.

The setting of care must be taken into account when analyzing prior research on the rates of imaging orders. The most similar study to this one examined the use of physical therapists operating in an emergency department in Australia.[16] Physical therapists ordered radiographs on 54% of patients with musculoskeletal injuries (excluding high-risk trauma, open fractures, multiple comorbidities, evidence of drug-seeking behavior, and altered consciousness). Physical therapists managed 47% of patients independently; 84% of injuries involved the upper or lower extremity. The physical therapists in this study ordered radiographs less frequently and the body region distribution of injuries was similar (88% involving the extremities).

In two studies of physical therapists operating in a direct-access setting in the United Kingdom, 5-7% of patients were referred for imaging.[17,18] Of those patients, 35-54% were evaluated for lumbar or cervical spine disorders of unknown chronicity. While it appears that the physical therapists in the current study ordered imaging at much higher rates (40% radiographs, 8% MRI/MRA), the sample in this study appears different as patients were evaluated primarily for extremity disorders (88%), more than half of which were acute injuries.

Physical therapists screening patients referred to orthopedic surgery clinics ordered imaging at a rate of 14% for radiographs and 27% for MRI.[20] These patients were older (mean age 48) than the patients described in this study and were already screened by a primary care provider, potentially lessening the need for additional imaging. Additionally, another study in the UK described imaging rates of 13% for plain radiographs and 10% for MRI by physiotherapists evaluating knee and lumbar spine disorders. In the current study, the rate of MRI/MRA orders was 8%, which suggests physical therapists did not overutilize these advanced imaging modalities.

The results of the current study are similar to previous work by Moore et al, performed at the same facility, describing the clinical diagnostic accuracy of physical therapists.[3] In that study, the overall clinical diagnostic accuracy was 75%, the accuracy of three board certified physical therapists was 86%, and the accuracy of two non-board certified physical therapists was 50%. The overall accuracy of the physical therapists in this study was slightly lower (65%), while the accuracy of the non-board certified physical therapist was similar (47%). While the physical therapists in both studies were all in the military, there was a variety of entry-level and post-professional training. The two board certi-

fied physical therapists in the study by Moore et al had a mean of 10.5 years of clinical experience, while the non-board certified physical therapist in this study had only one year of clinical experience. While the rates of diagnostic accuracy were similar between these two small samples of non-board certified physical therapists, the contribution of clinical experience versus board certification is not able to be determined.

There are several limitations to this study. The sample of physical therapists was small; only one non-board certified physical therapist with one year of clinical experience was included. The three board certified physical therapists had a mean of 11 years of clinical experience, many of which were in a direct-access setting. While there were no significant differences in ACR compliance between the board certified and non-board certified providers, there was a statistically significant difference in clinical diagnostic accuracy. Entry-level training may be sufficient to allow physical therapists to order diagnostic imaging appropriately. It is not known if the difference in clinical diagnostic accuracy was due to differences in clinical experience, formal imaging training, residency/fellowship training or board certification. A larger sample of physical therapists is needed to fully examine the effects of clinical experience and post-professional training on diagnostic accuracy.

A retrospective study can be a design limitation; however, it may have added credibility by reducing provider bias associated with the Hawthorne effect. The use of MRI as the main reference standard for clinical diagnostic accuracy is a limitation. However, utilization of surgery as a reference standard would not be feasible as only 20% of diagnostic imaging orders eventually required surgery. Additionally, ACR criteria are not available for every diagnosis and/or clinical presentation. The radiologist examining the case files determined either the most appropriate criteria to use or whether the case did not fit any existing criteria.

Future research should utilize a larger sample with a large range of clinical experience and attempt to directly compare the appropriateness and utilization of physical therapists and other providers operating in similar patient care settings. A retrospective design is likely needed given the strong possibility of the Hawthorne effect with this type of research if the providers are aware that their clinical practice pattern is being observed. A multi-center study may further investigate the effects of clinical experience, formal imaging training, residency/fellowship training, and board certification on clinical diagnostic accuracy. Examination of physical therapists with similar clinical experience who are and are not board certified may better inform the impact of board certification. Finally, future studies should examine the effect of physical therapist imaging on outcomes, such as exploring if the early utilization of imaging impacts the risk for surgical intervention or influences outcomes.

CONCLUSION

Physical therapists operating as musculoskeletal primary care providers in a direct-access sports physical therapy clinic appropriately ordered advanced diagnostic imaging in over 80% of cases. They ordered MRI/MRA in only 8% of all new evaluations, suggesting judicious use of advanced imaging. Future research should prospectively compare physical therapist appropriateness and utilization of diagnostic imaging to other groups of providers and explore the effects of physical therapist imaging privileges on outcomes.

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Appendix

Modified Example of ACR Appropriateness Criteria for Acute Trauma to the Knee

Legend:
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate.
Relative Radiation Level (RRL): ☢, Adult effective dose estimate range < 0.1 mSv; ☢☢, Adult effective dose estimate range 0.1-1.0 mSv.

Variant 1: Patient any age (excluding infants) who sustains a fall or twisting injury. Physical exam demonstrates no focal tenderness and no effusion. The patient is able to walk. First study.

Radiologic Procedure	Rating	Relative Radiation Level (RRL)
Knee X-ray	2	☢
MRI without contrast	2	None
MRI/MRA knee with and without contrast	1	None
CT knee without contrast	1	☢☢
Ultrasound knee	1	None

Variant 2: Patient any age (excluding infants) who sustains a fall or twisting injury. Physical exam demonstrates one or more of the following: focal tenderness, effusion, or inability to bear weight. First study.

Radiologic Procedure	Rating	Relative Radiation Level (RRL)
Knee X-ray	9	☢
MRI knee without contrast	5	None
Ultrasound knee	2	None
CT knee without contrast	2	☢☢
MRI/MRA knee with and without contrast	1	None

Variant 3: Patient any age (excluding infants) who sustains a fall or twisting injury with either no fracture or a Segond fracture seen on radiographs. Physical exam demonstrates one or more of the following: focal tenderness, effusion, or inability to bear weight. Next study.

Radiologic Procedure	Rating	Relative Radiation Level (RRL)
MRI knee without contrast	9	None
CT knee without contrast	5	☢☢
MRI knee with and without contrast	1	None
Ultrasound knee	1	None